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Online Share Trading, Time Constraints and Decision Making: Where less is better

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Abstract

The nature of investing in share markets is undergoing significant changes due to the growth in electronic or online trading. Online trading has meant increased trading by new types of traders, often relatively inexpert. This paper reports a study that investigated whether more active trading by novice traders, meaning reduced decision making time, was associated with lower trading performance. The results of an experiment with 39 novice traders and a simulated online market, using the Financial Trading System of O'Brien and Srivastava (1991), confirmed the hypothesis that time constraints on decision making adversely affected performance. The cognitive abilities of traders were measured with an online instrument, e-bilities®, as a control. Higher crystalline intelligence was related to higher performance, though fluid intelligence was not. The results suggest that in online trading, less is not more, and more considered decision making can yield greater returns. Relatively inexpert traders with less well developed cognitive abilities relevant to trading may also be at a disadvantage.

Keywords: Decision making, Time constraints, Fluid, Crystalline, Cognitive abilities

1. Introduction

The nature of investing in share markets is undergoing significant changes due to the growth in electronic or online trading. Financial markets are moving from the trading pit, or trading floor, to electronic trading. $100 billion of assets were traded online in the USA in 1997. Trading that used to be conducted by shouting out offers and bids in a crowded trading pit has been replaced by the more impersonal processes of computer based trading. Trading has become easier and cheaper. Housewives, plumbers, dentists and lawyers now go online to trade and manage their personal portfolios. These new types of traders are bypassing brokers and other experts to make buy and sell decisions based on their own research and analyses of individual stock. The majority of them are less well informed than the financial practitioners who formerly carried out the bulk of trading.

Understanding of the trading behaviour that occurs in this new environment is limited. One of the few relevant empirical studies is that of Barber and Odean (2002), who found that investors who switched from phone-based to online trading were trading more actively, more speculatively, and less profitably than before – lagging the market by more than 3% annually. Reductions in market frictions (lower trading costs, improved execution speed, and greater ease of access) did not explain these findings. Instead, the authors ascribed the findings to overconfidence – augmented by self-attribution bias and the illusion of knowledge and control.

Barber and Odean's study is an example of a paradigm known as behavioural finance (see Shleifer, 2000), which considers the effects of human biases, emotions and cognitive abilities on the behaviour observed in markets. This paradigm challenges the dominant paradigm in the study of finance, which is based on the central proposition of the Efficient Market Hypothesis (EMH), which assumes rational behaviour, and does not take into account investor biases, limited cognitive ability, and emotions. The current study is in the behavioural finance tradition and considers the effects of time pressure on performance in online trading. We add to the work by Barber and Odean (2002) by studying trading behaviour in a simulated share trading environment, where the time constraints under which decision makers operated could be explicitly measured. The objective of the paper is to address the research question:

> *Does trading under time constraints for the speed of decision making affect performance in online share trading?*

Work in the psychology and organizational behaviour areas suggests that performance will be adversely affected by reduced time for decision making. Several studies have found as a side result that time constraints had a negative influence on decision making (Kerstholt 1994; Rothstein 1986; Wallsten & Barton 1982).

Controls were included in the study for cognitive ability and understanding of the online trading game. It is possible that traders with greater cognitive ability are better able to carry out decision making.

This study is important as it adds to the very sparse empirical literature on online share trading. It has theoretical significance in that it investigates factors suggested as important in the behavioural finance paradigm, but not accepted in the rational EMH tradition. This study has practical significance in that a greater understanding of participant behaviour in online trading can potentially inform the design of trading systems and the decision support tools that can be made available in these environments.

This paper proceeds by reviewing the literature that leads us to expect a negative relationship between reduced decision-making time and performance and a positive relationship between cognitive abilities and performance. The experiment performed with an online trading game, the Financial Trading Systems (FTS) of O'Brien and Srivastava (1991), is then described. Results are given for the regression analysis performed followed by a discussion of the implications of these results.

2. Conceptual Background and Hypotheses Development

Numerous empirical studies have concluded that time pressure has a significant impact on decision strategy (Ben Zur and Breznitz 1981; Wright 1974; Zakay and Wooler 1984) and effectiveness (Peters and O'Conner 1980; Peters et al. 1984). Wright (1974) found that decision makers adopted simplified strategies when time pressure was high and placed greater emphasis on negative information for decision alternatives. Ben Zur and Breznitz (1981) also found their experimental participants focused more upon negative information and that they also preferred less risky alternatives under time pressure. Research by Zakay and Wooler (1984) supported Wright's findings and in addition found that as time pressure increased, decision quality decreased. Other studies have found as a secondary result that time constraints appeared to have a negative influence on decision making (Kerstholt 1994; Rothstein 1986; Wallsten & Barton 1982).

It is important to note that the use of the terms “time constraint “ and “time pressure” are often used interchangeably in the literature (Svenson and Maule 1993). For the purposes of this study, we will distinguish between the two concepts, following Ordonez and Benson (1997):

- Time Constraint – A deadline/time restriction imposed upon a task when the decision maker has a limited amount of time in which to make the decision. This constraint is often fixed to a particular value for experimental purposes, either arbitrary or based on previous findings.

- Time Pressure – The stress induced as a result of time constraint on a human decision maker. It is possible to have time constraint but not time pressure when the decision maker can arrive at a decision within the time constraint period.

Reduced performance is expected when there are time constraints because a decision maker is likely to engage in non-compensatory rather than compensatory decision-making. Compensatory processes tend to involve all available information in the decision process, whereas non-compensatory processes involve only a portion of the total available information (Payne et al. 1993). A study by Hogarth (1987) found that compensatory processes may lead to decisions of higher quality but at the cost of increased cognitive load.

Chu and Spires (2001) identified a failing in current decision support (DSS) research where decision makers are granted virtually unlimited time to perform tasks. This “time freedom” is at odds with the real-world where decision makers tend to be under time pressure for their decision making process, though the time constraint varies upon task and environment conditions. This gap in DSS research was partially explored in decision-making research where studies by Payne et al. (1996), Stern (1999) and Verplanken (1993) focused on shorter time constraints (ie. less time available for decision making). Stern (1999) found a significant difference between 25 seconds and 5 seconds, with the latter making the subjects feel that the time restriction affected their decision-making. There was no significant difference between 25 seconds and 10 seconds and between 10 seconds and 5 seconds in this study.

In the share trading environment there is a limited amount of time for decision making if a trader chooses to trade often. The FTS trading system used in this study provides an interface and trading environment similar to that of real-life systems such as SEATS used on the Australian Stock Exchange. The study by Barber and Odean (2002) found that with online systems, traders traded more actively than with phone trading. In this case the time constraint is self-imposed, rather than being imposed by external conditions. It is expected that the more trading actions performed by each individual within a time period, the worse their performance will be, possibly due to a shift towards, or in part, a non-compensatory decision process. These considerations lead us to our first hypothesis:

> *H1: A higher level of share trading activity in a given period is associated with lower performance in financial trading.*

In considering performance in share trading we can also consider the cognitive abilities of the traders. In general, with a task that requires judgement, we would expect in general, that individuals who have higher level cognitive abilities and more expertise can better process information and exhibit higher performance levels. In our current study we are not investigating levels of expertise but rather are interested in traders who are relative novices at their tasks – the dentist and housewife-type traders rather than professional share traders. However, it appears possible that the cognitive abilities of relative novices may affect their performance, so we have included consideration of this factor in our study as a control.

Existing research by Horn (1982; 1985; 1987) provides a general framework for understanding cognitive abilities. This theory identified two broad domains of intellectual functioning that are referred to as fluid and crystalline intelligence. Often an IQ-like variable is used to measure cognitive ability. In contrast, the theory of fluid and crystallised intelligence postulates a range of abilities that influence performance.

The concept of fluid ability is similar to the concept of "raw" intelligence, the innate reasoning ability that people have regardless of the culture into which they are borne. Fluid abilities develop over time as the brain matures neurologically and start to diminish in middle to late adulthood. Crystalline abilities are the general knowledge of facts, strategies and skills that are the result of education, training and experience. Individuals develop these knowledge types during their lifetime and it is often referred to as "wisdom" in later years. There is overlap between crystal and fluid intelligence and both share characteristics in the processes of perceiving relationships, logical reasoning, abstraction, concept formation, problem solving and the like. There is a range of other broad abilities that play a part in human performance by contributing to either fluid or crystallised ability: broad visual ability, working memory, long-term memory, cognitive speed and quantitative knowledge. Individual differences exist between fluid and crystallised abilities, which mean that some people are better at processing information for tasks than others.

Cognitive ability is expected to be a significant predictor of work performance (Anstey 1999). Carroll (1993) found individuals with high fluid ability tended to have better "working memories" and were faster at problem solving. This advantage should manifest itself in a time constrained environment where decision makers with higher fluid intelligence can "out think" their competitors, with a resulting increase in financial performance. Thus:

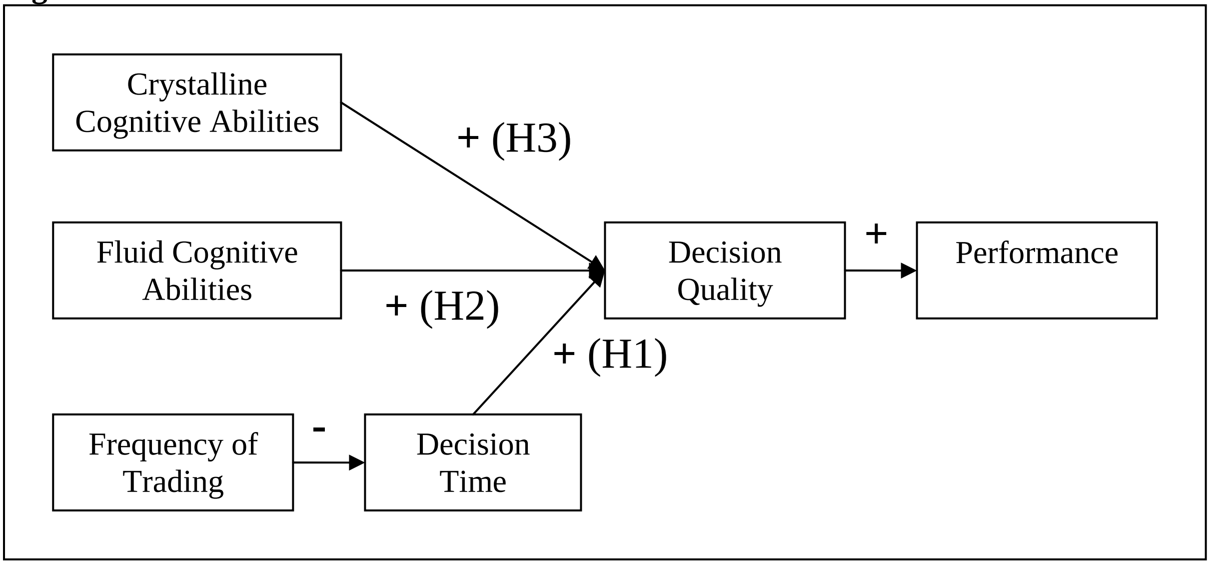
> *H2: Higher levels of fluid cognitive ability will be associated with higher performance in financial trading.*

Similarly, crystalline abilities in the form of verbal skills (necessary for processing informational cues) and quantitative knowledge (numerical operations and financial reasoning) should also be associated with higher levels of performance in share trading.

> *H3: Higher levels of relevant crystalline cognitive abilities will be associated with higher performance in financial trading.*

Figure 1 presents in diagrammatic form the research model resulting underlying these hypotheses. Not all the links in Figure 1 were tested as some are intervening links to better explain what happens. The three hypotheses developed were tested in an experiment as described in the following section.

Figure 1 Research model



3. Research Method

3.1 Participants

Participants were 43 volunteers from a class of approximately 400 students in a first year university finance course. This sample consisted of 17 females and 26 males. The median age range was 20 years. Approximately 72% of the participants indicated that English was not their first language, though due to being undergraduate international students, they met the minimum TESOL English proficiency standard that was a requirement of their enrolment.

3.2 Procedure

The experiment had two parts, an initial training session and the experiment proper.
In the training session each participant first completed an *e-bilities*® test to measure cognitive abilities, which took approximately 45 minutes. The participants were then shown how to use the Financial Trading System (FTS) used in the experiment. They then participated in four trials of the system under conditions similar to those of the experiment proper. Each trial consisted of two 5 minute periods of trading. This part of the first session took approximately one hour.

The session for the experiment itself took two hours and had six trials, each with two 5 minute periods of trading. Participants were given an additional survey in the experimental session to assess their level of understanding of the rules of the trading game and how to perform operations with it. This measure was included for control purposes, to ensure that participants' level of understanding of the game was not responsible for differential performance.

3.3 Materials

A Java-based testing suite called e-bilities® (http://www.ebilities.com), developed by the Lewis Cadman Group[1], was used to test cognitive abilities. The customized e-bilities® test suite used collected demographics (name, occupation, education, English ability, age, gender and ethnicity) and cognitive measures (Swaps®, Triplets™, Series, Word and Quantitative Knowledge). The instrument has been privately validated and further information is available on request. Appendix 1 shows the cognitive measures used for this particular study.

The real-time trading software package used was the Financial Trading System (FTS) (http://www.ftsweb.com) which was developed by OS Financial Trading System[2] and is described in O'Brien and Srivastava (1991). It is used to create experimental financial trading markets. The system provides participants with trading experience in a simple market environment. The "market efficiency" game used in this study is the simplest of a comprehensive set of market games supplied by OS Financial Trading Systems.

Trading occurs over two periods and the assets pay a dividend at the end of each trading period. Market participants have limited information about the dividend payments and so they must use the information given to them as well as the information provided in the reported share prices to determine the actual value of the shares. For example it is possible that the participant might receive the information that the dividend in period 1 is not X and the dividend in period 2 is also not X. If this information is received for the share, ABC, then ABC must take on some value greater than zero. If this hint is provided for CRA then at the beginning of the game the participant knows that CRA will take a value of either 8, 12, 18, 20, 24, 30, 32, 36 or 42, each with a probability of 1/9. This is a difficult valuation question for each individual though the individual can work out the expected value of 24.7. At the beginning of the second period there is a 1/3 probability of receiving 8, 12 or 18 with expected value of 12.7. Each of the participants in the market receives similar levels of incomplete information with sufficient information made available to the market as a whole to identify exactly what the value of the share is.

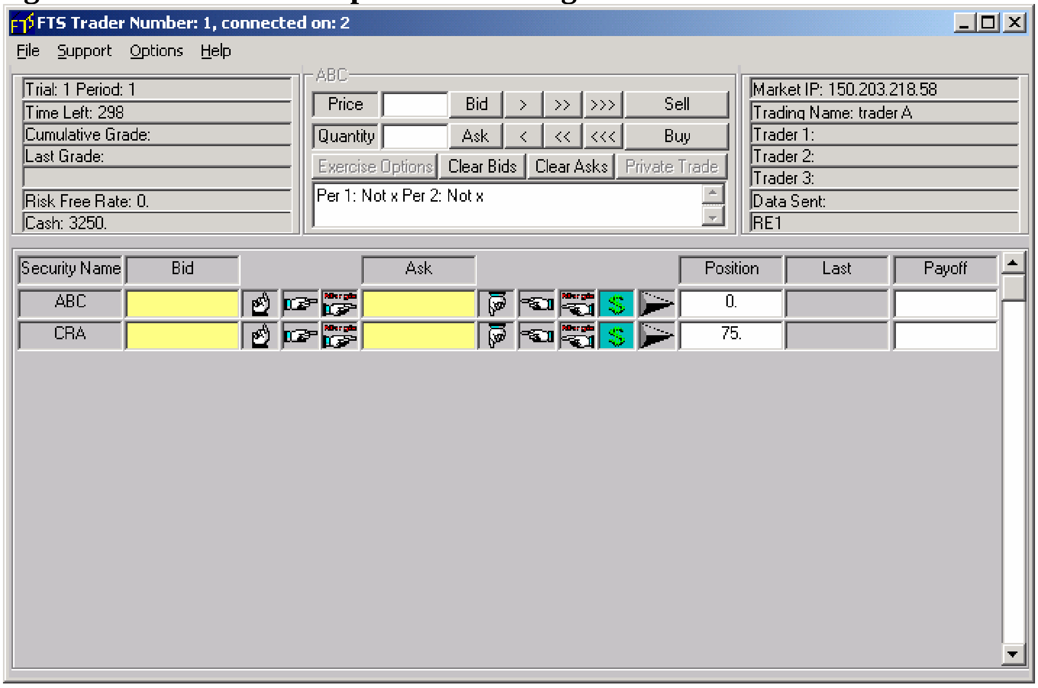
We chose a trading period of about two hours, split into six 10-minute trials, with each trial consisting of two 5-minute trading periods, period 1 and period 2. At the beginning of the game the participants are allocated cash and securities though the split between these two asset categories varies across the individuals. They are also given incomplete information on the dividends that are to be paid at the end of each of the two trading periods. Once trading begins the participants flag their wish to buy or sell securities by entering a bid or ask price or they might choose to accept existing ask or bid prices.

A copy of the trading screen is provided in Figure 2. The key features of the game are apparent in this screen dump including the facility to enter bid and ask price and quantity as well as disclosure of other important information about the game such as the current bid and ask prices and the current position of the participant in each of the two stocks, ABC and CRA. The two securities may pay dividends at the end of period 1 and period 2 and the central white rectangle contains the participant's information about the dividends that the shares will pay.

The time left, upper left corner, is a critical piece of information as it informs the participants of when the market is trading and how much time remains in the present trading period. In the training and experiment, though not in the course based tutorials, the nominal fee paid to each participant consisted of a fixed component and a variable component based on trading. At the end of each trial each participant's performance was compared with a randomly drawn benchmark and compensation was paid where performance exceeded the benchmark. Thus the participants were encouraged to maximise trading profit in each trial.

All actions made by each participant were recorded by the market server and from this, the market structure could be statistically analysed.

Figure 2 Screen dump for the trading screen in FTS



3.4 Design

The dependent variable was the measure for *financial performance* - the final grade cash recorded at the end of the experiment, which indicated the financial situation of the participant at the conclusion of trading.

One independent variable was the indicator for time constraint - the number of trading actions initiated by the participant, that is, the *total number of ask, bid, buy and sell actions.* The more actions a person undertook, the less decision time available for each action.

The two measures for cognitive ability, Crystalline Cognitive Abilities and Fluid Cognitive Abilities were additional independent variables (Appendix 1).

A measure of understanding of the structure and operations of the trading game was included as an additional independent variable as a control.

Linear regression was used for analysis. Before analysis the data was screened to test for the assumptions underlying regression analysis. One case was removed because of missing data. Three cases were removed as outliers, having data values more than three standard deviations from the mean and distant from other observations. This process left 39 cases for analysis.

4. Results and Discussion

Table 1 shows the descriptive statistics for the important variables in the study.
Table 2 shows the results of the regression analysis. The model was significant with p = .004 and R^2 = 0.361 (adjusted R^2 = .286).

Table 1 Descriptive statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Financial Performance ($)	39	-1217.52	432.47	-67.8157	336.20491
Total # of Ask, Bid, Buy and Sell actions	39	58.00	1542.00	513.6667	398.79861
Crystalline Cognitive Abilities (0.0-1.0)	39	.27	.81	.5491	.15544
Fluid Cognitive Abilities (0.0-1.0)	39	.43	.99	.8363	.10389
Overall Understanding (max. 15)	39	1.00	14.00	6.3077	3.51803
Valid N (listwise)	39				

Table 2 Results of regression analysis

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-545.432	426.192		-1.280	.209
	Total # of Ask, Bid, Buy and Sell actions	-.417	.120	-.495	-3.484	.001
	Crystalline Cognitive Abilities (0.0-1.0)	915.062	327.063	.423	2.798	.008
	Fluid Cognitive Abilities (0.0-1.0)	298.605	468.351	.092	.638	.528
	Overall Understanding (max. 15)	-9.540	15.201	-.100	-.628	.534

The results show that Hypothesis 1 was supported. The amount of time available for decision making was negatively related to trading performance. Those participants who traded more (had more trading actions) performed less well. The rate of trading by the most active traders was very high. The most active trader made 1542 trading decisions in the 60 minutes of trading, meaning that a decision was being made every 2.33 seconds on average.

The hypotheses concerning cognitive abilities were supported in part. Crystalline intelligence was significantly related to performance (H1) while fluid intelligence was not (H2).

Overall understanding of the FTS game was not significantly related to performance. This measure was introduced into the analysis as a control variable, to guard against the situation where performance was influenced by degree of understanding of the game itself. The lack of significance of this variable indicates that knowledge of the game itself was not a differentiating factor in performance level achieved. Other demographics, including gender, age, and prior experience with financial trading were also examined as potential covariates, but had no significant relationship to trading performance was indicated.

5. Discussion

The results of this study provide support for the importance of considering human behaviour, especially in relation to decision-making, in the study of finance. The results from the experiment show clearly that more active traders, who make a larger number of decisions in a given time period, perform less well than their less active counterparts, who have more time for considered decision making. It is likely that this drop in performance can be ascribed to non-compensatory decision-making, where all available information cannot be included in a decision because of a lack of time. Future studies will focus upon strategies being used in an attempt to get a better understanding of their decision making methods.

The intellectual abilities of the traders were shown, in part, to be related to performance. Crystalline intelligence, indicated by verbal, numerical and financial reasoning abilities, was related to performance. This finding indicates that traders who have acquired more knowledge relevant to the trading environment will perform better. On the other hand, the fluid intelligence measure, which indicates innate reasoning abilities, was not related to performance. These findings together suggest that acquired knowledge is more important for financial trading than non-specific abilities for reasoning.

The study has some limitations. The participants were first year students and results may not be generalizable to other populations, such as experienced day traders. However, online trading systems are now being used by non-expert traders, and our student participants may be reasonably representative of these inexpert traders that only possess a limited grasp of trading concepts with low levels of actual trading experience.

This study is the first, as far as the authors are aware, that has examined decision-making time and cognitive abilities as determinants of trading performance. Thus, there is an opportunity for further research to examine whether the finding can be replicated by other researchers.

Despite potential limitations, the study has implications for practice. Results support the concerns of Barber and Odean (2002) that the switch to online trading may not be of benefit to many inexpert traders, who have been able to participate more fully (and more actively) in trading with the advent of online investing. These traders may be trading too often and too quickly, and not making sufficiently considered trading decisions. Our study has also shown that learned cognitive abilities, including verbal, quantitative and financial reasoning skills, are also an advantage in trading. Again there is cause for concern where traders of less ability are actively trading.

Consideration of our findings may benefit designers of online trading systems and decision support systems. The performance of participants in online trading may be improved if they are encouraged to consider their decisions in 'slower time' and provided assistance through decision support with financial and quantitative reasoning where their own acquired knowledge is deficient.

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Appendix 1 e-bilities® cognitive abilities

Classification	Name	Description
Fluid	Swaps®	The test-taker has to mentally interchange or "swap" the position of three geometric shapes. The four levels of the test place progressively higher demands on working memory and attentional resources.
	Triplets™	The test-taker has to commit to memory a rule relating to how numbers appear in a series. They then have to make decisions based on what they have memorized. The test increases in difficulty as the rules become more complex.
	Series	The test-taker has to type in a number that continues a given series of numbers.
Crystallised	Vocabulary	A measure of word-based problem solving and requires the test-taker to choose a synonym for a given word amongst four alternatives.
	Word Analogies	The test-taker has to determine the connection between two words and then find a word that has the same relationship to a third word.

Endnotes

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[2] OS Financial Trading Systems, P.O. Box 11356, Pittsburgh, P.A. 15238, Toll free (within US): 1 800 967 9897, Phone USA (412) 967 9367, Email address: fts@ftsweb.com, Web address: www.ftsweb.com